

REMARKS

Claims 1-8 of the amended sheets have been cancelled and new claims 9-19 added. Thus, claims 9-19 are presented for examination. Applicant respectfully requests allowance of the present application in view of the foregoing amendments.

Any amendments in the International Phase are hereby incorporated by reference in their entirety in the present Preliminary Amendment.

The amendments are not made for purposes of patentability.

A substitute specification incorporating the changes in this preliminary amendment is provided with this application. No new matter has been added by way of the substitute specification.

Conclusion

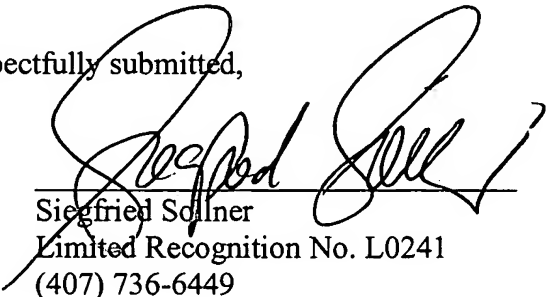
The commissioner is hereby authorized to charge any appropriate fees due in connection with this paper, including the fees specified in 37 C.F.R. §§ 1.16 (c), 1.17(a)(1) and 1.20(d), or credit any overpayments to Deposit Account No. 19-2179.

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**APPARATUS ARRANGEMENT FOR THE TRANSMISSION OF DATA, AND
HAND-HELD ELECTRONIC UNIT AND FIELD DEVICE FOR SUCH AN
APPARATUS**

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to the German application No. 10344575.7, filed September 25, 2003, and to the International Application No. PCT/EP2004/010758, filed September 24, 2004 which are incorporated by reference herein in their entirety.

FIELD OF INVENTION

[0002] The invention relates to an apparatus for transmitting data between a hand-held electronic unit and a field device ~~according to the preamble of claim 1 and a hand-held electronic unit and a field device according to claims 7 and 8 respectively for an apparatus of this kind.~~

BACKGROUND OF INVENTION

[0003] Field devices, e.g. for use as measuring transducers and/or final control elements in process plants, are generally known. They can be used to detect or influence process variables. To ensure that such field devices operate in the desired manner at their location, parameterization often has to be performed whereby in the case of a measuring transducer, for example, the lower and upper measuring range values are specified. If the field device is itself provided with an input keypad and a display, parameterization can be performed in a local operation, e.g. by means of mechanical keys or infrared reflection keys. As such operations are mainly performed on field devices during commissioning and rarely occur during subsequent operation, equipping the field device with an entry keypad and display involves a comparatively high cost.

SUMMARY OF INVENTION

[0004] US-PS 5,434,774 discloses an apparatus for the transmission of data between a hand-held terminal and a field device whereby the terminal is coupled to an existing current loop of a 4 to 20 mA interface and the data to be transmitted is frequency-modulated onto the 4 to 20 mA interface, thereby enabling the terminal to be used to parameterize the field device. Although this allows the field device to be operator-accessed locally, the disadvantage is that

the process values have to be transmitted using an analog current signal during normal operation. If a field device is employed with a field bus connection of another kind, the terminal cannot be used.

[0005] EP 0 788 627 discloses a distributed control system with field devices which are connected to a hard-wired network. To obviate the need for laborious parameterization of the field devices via the network, the field devices additionally have a wireless interface by means of which a wireless connection can be established between the field device and an operator's hand-held electronic unit. The wireless connection can be implemented e.g. by a radio, optical or acoustic transmission link. The power required for operating the field device is supplied via the hard-wired network port. While this means that no extra lines in addition to the network port are required for supplying the field device with operating power, the disadvantage is that the power consumption of the field device increases due to the additional wireless interface and therefore less power is available for the actual operation of the field device, as the amount of power that can be drawn from the network is usually very limited.

[0006] EP 0 929 948 B1 describes a modular electronic control for use in a process plant whereby operating power and data are wirelessly transmitted between the individual modules.

[0007] The An object of the invention is to create an apparatus for transmitting data between a hand-held electronic unit and a field device whereby the data can be transferred wirelessly and the field device's power demand on an operating power supply during data transfer is no more than slightly increased compared to its power demand during normal operation. Further objects are to create a hand-held electronic unit and a field device for such an apparatus.

[0008] To achieve this object, the new apparatus of the abovementioned type has the features set forth in the characterizing portion of claim 1. Advantageous further developments are described in the dependent claims. In claim 7 is specified a hand-held electronic unit, in claim 8 a field device for such an apparatus for the transmission of data.

[0009] The advantage of the invention is that it enables a hand-held terminal to be used to access a field device locally, i.e. not from a remote console, for example. No additional outlay is required, such as opening a field device enclosure or attaching connecting leads to existing communication lines via which the field device transmits its measured values to a higher-level

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station. As the power consumption of the field device is not unduly increased by communication with the terminal, the field device can continue to be supplied with the amount of power it normally requires for operation, e.g. via a network port which is present anyway. As the operating power input required is increased no more than slightly by data transmission between field device and hand-held electronic unit, this additional interface does not require any other lines to be provided for powering the field device.

[00010] The field device coupling piece is preferably disposed on the field device enclosure. The advantage of this is that no additional cable is required between field device coupling piece and field device and the enclosure of the field device can be of simpler construction, as the proximity connection between cable coupling piece and field device coupling piece can be implemented through a wall section of the enclosure, for example.

[00011] Advantageously a proximity connection, once set up, continues to exist without further operator effort if the cable coupling piece is detachably held to the field device coupling piece. When the cable coupling piece has been attached, it can be held automatically to the field device coupling piece by magnetic adhesion. Advantageously the operator then has his hands free for operating the hand-held electronic unit.

[00012] If the hand-held electronic unit is implemented as an operator terminal for the field device and is provided with an entry keypad and a display, this has the advantage, in combination with a field device whose electrical connection is implemented as a network port, that no keypad or display needs to be provided on the field device itself to access it. For linking the field device into a control network of an industrial plant, the device's network port suffices. The instrumentation required for local operation of the field device, in particular the entry keypad and display, is therefore transferred to the terminal. The cost associated with the very occasional accessing of the field device locally relative to its service life is reduced overall.

[00013] A further reduction in the power consumption of the field device during normal operation is advantageously possible if a field device circuit required for data transmission via a proximity connection assumes, during normal operation, a standby state with lower power demand which it only leaves when the proximity connection is established and used for data transmission.

[00014] The invention can be used particularly advantageously with field devices which have to satisfy explosion protection requirements. The absence of a plug and socket connection with electrical contacts eliminates the otherwise necessary expense of implementing an intrinsically safe interface and there is no need for a cover over the field device coupling piece. Moreover, the mechanical or atmospheric stress on the contact elements of a plug and socket connection would be disadvantageous, as field devices are usually intended for use in harsh industrial environments.

BRIEF DESCRIPTION OF THE DRAWINGS

[00015] The invention and its embodiments and advantages will now be explained in greater detail with reference to the accompanying drawings illustrating an exemplary embodiment and in which:

[00016] Figure 1 shows a hand-held terminal and a field device with an apparatus for the transmission of data and

[00017] Figure 2 schematically illustrates a wireless proximity connection.

DETAILED DESCRIPTION OF INVENTION

[00018] Figure 1 shows a hand-held terminal 3 and a field device 2 which are interconnected via a cable 1 of an apparatus for transmitting data. The field device 2 is, for example, a pressure transducer mounted on a pipe run 5 of a process plant not shown in greater detail. Using a network port 6, the field device 2 is connected to a network via which it communicates with a higher-level control station 12, e.g. signals the measured pressure values to the control station 12, and via which the field device 2 is supplied with the power required for its normal operation in the process plant by an operating power supply 13 in the control station 12. If the field device 2 is to be parameterized locally, the terminal 3 is connected to the field device 2 via the apparatus for transmitting data and the operating power required by the field device 2 for data transmission. The terminal 3 has a keypad 7 and a display 8 via which an operator can make entries to and receive outputs from the field device 2. No operator equipment of this kind is any longer required on the field device 2. The apparatus for the transmission of data has a cable 1, one end of which has a connector 9 inserted in a mating receptacle 10 of the terminal, thereby establishing an electrical connection between cable 1

and terminal 3 for transmitting the power required by the field device 2 for data transmission, and also an optical connection for transmitting the data. In the terminal 3 there is provided a suitable circuit for operating the interface. The other end of the cable 1 is provided with a cable coupling piece 4 which can be connected to a corresponding field device coupling piece 11 to establish a wireless proximity connection. Via this proximity connection, data can be transmitted bidirectionally between the terminal 3 and the field device 2 and the operating power required by the field device 2 for the transmission of data can be transmitted from the terminal 3 to the field device 2. The transmission principle will now be explained in greater detail with reference to Figure 2. In Figures 1 and 2 identical parts are provided with the same reference numerals.

[00019] Figure 2 shows the basic design of a wireless proximity connection. This is established by inserting the cable coupling piece 4 into a field device coupling piece 11 implemented to accommodate it in a form-fit manner. For the sake of clarity, Figure 2 shows the state shortly before complete insertion of the cable coupling piece 4. As the proximity connection is implemented wirelessly, no electrical contacts of any kind are required and the field device coupling piece 11 can be implemented by a section of an enclosure wall 20 of the field device 2. To accommodate the cable coupling piece 4 in a form-fit manner, the wall 20 of the enclosure is recessed in this area. In the center of this recessed section there is provided a window 21 through which optical signals of an optical transceiver 22 of the field device 2 are coupled into or out of an optical waveguide 23 of the cable coupling piece 4. The optical waveguide 23 is routed through the cable 1 alongside electrical leads which are not shown for the sake of clarity. The operating power required for supplying circuit sections 24 of the field device 2 that are involved in data transmission is transmitted by means of two inductive transformers 25 and 26, one coil of which is disposed in the cable coupling piece 4 and a second coil is disposed in the field device coupling piece 11 in each case. The circuit 24 of the field device 2 required for data transmission via the proximity connection is placed in an active state when the proximity connection is established and the required operating power is supplied via the proximity connection so that data can be transmitted. On the other hand, during times in which no wireless proximity connection is present, the circuit 24 is in a standby state in which it requires only a very small amount of operating power. This ensures that the power consumption of the field device 2 as a load on the network of a control system for the process plant is only slightly increased by the

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transmission of data between terminal 3 and field device 2. Other electronic circuit sections of the field device 2 to which the circuit 24 is connected, such as a microprocessor with a memory in which the transmitted parameters are stored, have not been shown for the sake of clarity. When inserted in the field device coupling section 11, the cable coupling section 4 is detachably retained by a ring magnet 27 of rotationally symmetrical design. An interface controller 28 can be implemented for communication according to any desired protocol. Preferably, however, a widely used protocol, e.g. in accordance with a PROFIBUS or HART standard, is employed.

[00020] As is clear from the exemplary design of a wireless proximity connection shown in Figure 2, this is particularly advantageous for use in explosion-prone areas, as there is no enclosure cover or similar to be opened in order to connect the cable coupling section 4 to the field device coupling section 11. In addition, there are no fault-prone electrical contacts in the wireless proximity connection.

[00021] As an alternative to the example described, instead of optical data transmission, data can be transmitted in a physically identical manner to power transmission, e.g. using different frequency bands for data and power transmission. This has the advantage that the additional transceiver 22 and the window 21 penetrable by the optical signals can be dispensed with. As a further alternative, capacitive data and/or power transmission is possible.